# Physical activity patterns of patients with cardiopulmonary illnesses

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## Abstract

**OBJECTIVES**—The aims of this paper are to: 1) describe objectively-confirmed physical activity patterns across three chronic cardiopulmonary conditions, and 2) examine the relationship between selected physical activity dimensions with disease severity, self-reported physical and emotional functioning, and exercise performance.

**INTERVENTIONS**—Not applicable.

**DESIGN**—Cross-sectional study.

**SETTING**—Participant's home environment.

**PARTICIPANTS**—Patients with cardiopulmonary illnesses: chronic obstructive pulmonary disease (COPD, n=63), heart failure (HF, n=60), and patients with implantable cardioverter defibrillator (ICD, n=60).

**MAIN OUTCOME MEASURES**—Seven ambulatory physical activity dimensions (total steps, percent time active, percent time ambulating at low, medium, and high intensity, maximum cadence for 30 continuous minutes, and peak performance) were measured with an accelerometer.

**RESULTS**—Subjects with COPD had the lowest amount of ambulatory physical activity compared to subjects with heart failure and cardiac dysrhythmias (all seven activity dimensions, $p<.05$); total step counts were: 5319 vs. 7464 vs. 9570, respectively. Six minute walk distance were correlated ($r=.44$ to $.65$, $p<.01$) with all physical activity dimensions in the COPD sample, the strongest correlations being with total steps and peak performance. In subjects with cardiac impairment, maximal oxygen consumption had only small to moderate correlations with five of the physical activity dimensions ($r=.22$ to $.40$, $p<.05$). In contrast, correlations between six minute walk test distance and physical activity were higher ($r=.48$ to $.61$, $p<.01$) albeit in a smaller sample of only patients with heart failure. For all three samples, self-reported physical and mental health functioning, age, body mass index, airflow obstruction, and ejection fraction had either relatively small or non-significant correlations with physical activity.

**CONCLUSIONS**—All seven dimensions of ambulatory physical activity discriminated between subjects with COPD, heart failure, and cardiac dysrhythmias. Depending on the research or clinical goal, use of one dimension such as total steps may be sufficient. Although physical activity had high correlations with performance on a six minute walk test relative to other variables, accelerometry-based physical activity monitoring provides unique, important information about real-world behavior in patients with cardiopulmonary illness not already captured with existing measures.

### Keywords

ambulatory physical activity; walking; monitoring; COPD; heart failure; implantable defibrillator; exercise performance

Cardiopulmonary diseases are the leading causes of morbidity and mortality worldwide.[1] Epidemiological studies based on self-reported physical activity show that higher levels of activity are associated with lower risk of incident chronic obstructive pulmonary disease (COPD) in smokers and in patients with COPD, decreased risk of hospital admissions, exacerbations and mortality.[2–4] A recent 4-year prospective study of 170 patients with COPD showed that objectively measured physical activity was the best predictor of all-cause mortality when compared with a broad range of other prognostic factors including airflow obstruction, exercise performance, cardiovascular status, nutritional and muscular status, systemic inflammation, health status, depressive symptoms, and dyspnea. Each increase of 1845 steps per day was associated with a 51% lower risk of death (HR, 0.49; 95% CI, 0.35–0.69).[5] The physiological processes underlying the relationship between physical activity and survival are complex and only incompletely understood. However, it has been hypothesized that inactivity leads to cellular and molecular dysregulation, which directly contributes to the development of multiple chronic conditions.[6, 7]

Similarly, associations have been found for self-reported physical activity with the primary and secondary prevention of cardiovascular diseases in a number of epidemiological studies.[6–9] However, far fewer studies have been published on objectively measured physical activity in select cardiac populations such as heart failure[10–12], severe cardiac dysrhythmias, or coronary artery disease to provide useful benchmarks of physical activity levels for comparisons across studies. Activity monitoring based on accelerometry can more precisely capture what patients actually do in their daily lives instead of what they report or what they are capable of with laboratory exercise testing.[13] While the pathophysiological processes in the development of COPD, heart failure, and cardiac rhythm disorders differ, we posit that decreased physical activity is a common pathway to impaired functioning and

disability in these and other chronic conditions[14] and that objective assessment of physical activity provides a unique but universal metric for comparison across diseases and studies. Therefore, the aims of this paper are to: 1) describe objectively-confirmed physical activity patterns across three chronic cardiopulmonary conditions, and 2) examine the relationship between selected physical activity dimensions with disease severity, self-reported physical and emotional functioning, and exercise performance.

## METHODS

### Participants

Between 2007 and 2010, a combined convenience sample of 183 outpatients at a Veterans Administration and university medical center were selected for study from the combined databases of three similar outpatient studies of activity patterns in cardiopulmonary illness.[15, 16] All subjects had either a diagnosis of COPD, a history of life-threatening cardiac arrhythmias, or heart failure and had been clinically stable for at least one month and under optimal medical management. All subjects were able to read, speak, and write English and were not carrying out more than two days of supervised exercise per week. Subjects were excluded if they had less than one year to live, active malignancy, hypoxia with exertion (oxygen saturation <86% during exercise testing), significant psychiatric illness or recent drug abuse that would impair participation, and neuromuscular disease that limited daily activity. In addition, subjects were excluded if they evidenced disease exacerbation, uncontrolled cardiac dysrhythmias, unstable angina, recent myocardial infarction (MI), or cardiothoracic surgery within the past three months. All three studies were approved by their respective institutional review boards and were registered with ClinicalTrials.gov (NCT00373932; NCT00522340, NCT00467298).

COPD Sample (N=63): The COPD subjects had to have at least mild COPD (GOLD Stage I) defined as a post-bronchodilator forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) ratio <0.70 with FEV1 >80% predicted with daily activities limited by dyspnea.

Heart Failure Sample (N=60): In addition to the general inclusion and exclusion criteria described earlier, heart failure subjects had to have an ejection fraction (EF) of 0.35[17, 18] and daily activities limited by dyspnea or fatigue.

Cardiac Dysrhythmia Sample (N=60): In addition to the general inclusion and exclusion criteria, the cardiac dysrhythmia sample had a history of life-threatening dysrhythmia that required the placement of an implantable cardioverter defibrillator (ICD) for secondary prevention of sudden cardiac arrest. These subjects were also on beta blockers.

### Measurements

*Demographic*s data included self-reported age, gender, education and marital status.

*Health Status* included self-report of chronic conditions (Charlson co-morbidity index), ejection fraction (EF) obtained from medical records, and spirometry which was performed according to American Thoracic Society (ATS) standards using a Koko spirometer.[a] Post bronchodilator values were used.

*Exercise Performance* was assessed using the six minute walk test (6MWT)[19] and a modified Balke treadmill symptom-limited test protocol.[20] Participants performed two

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[a]Pulmonary Data Services; Louisville, CO

6MWT according to ATS guidelines and the longer of the two tests was used for analysis. Maximum oxygen consumption (V02max) was measured during the cardiopulmonary exercise test session in an exercise laboratory and determined as the average value observed over the last 10 seconds of exercise[b].

*Ambulatory Physical Activity* was measured using a pager-sized, lightweight, Stepwatch[TM] 3 Activity Monitor[c] fastened above the right ankle. The SAM is a dual-axis accelerometer linked to a microprocessor sensor that directly and continuously records gait cycles (strides) based on acceleration, position, and timing information. Stride counts are doubled to represent steps. The SAM has been validated for use in healthy and chronically ill older adults in laboratory and community settings and has an accuracy of 98–99%.[21, 22] Participants were asked to wear the SAM during waking hours for seven days at baseline. The SAM was programmed to record in 1-minute epochs; a valid day was defined as having 10 or more hours (600 mins.) of monitor wear.

The Stepwatch software was used to produce the following physical activity dimensions: (1) total daily steps taken, percent time active, percent time spent ambulating at low intensity (1–30 steps/min), medium intensity (31–80 steps/min), and high intensity ( 80 steps/min), (2) max cadence for 30 continuous minutes which provides a proxy of walking intensity during a typical recommended bout of endurance exercise, and (3) peak performance which represents short walking bursts and is obtained by ranking all minutes of the day according to cadence, and then averaging the highest 30 values. These variables were calculated for each day, and then the daily values were averaged over the total monitoring period.

*Health related quality of life (HRQL)* was measured with the Medical Outcomes Study Short-Form 36 (MOS-SF36).[23] The SF-36 produces two composite scales of physical and mental functioning with higher scores indicating better HRQL.

## Data Analysis

Analysis of variance or Fischer's Exact tests were used to compare demographic, disease severity, functioning, and physical activity patterns across groups. Pearson correlation coefficients were computed for the bivariate correlations. All analyses were conducted using SPSS 15.0[d]. A p value <.05 was considered statistically significant.

# RESULTS

## Sample Characteristics

The COPD sample was the oldest with a mean age of 67. A majority of the total sample was obese Caucasian males with at least some college education (Table I). Although the heart failure sample had the highest chronic disease burden, their self-reported physical functioning score was better than the COPD sample. The younger sample with cardiac dysrhythmias had the worst mental health functioning score despite lower chronic disease burden and the highest physical functioning score of the three groups. The 6MWT was not significantly different between the COPD and heart failure sample. As expected, VO2max was significantly different between patients with heart failure and cardiac dysrhythmias.

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[b]Viasys VMax series 229, Sensor Medics, San Diego, CA, USA
[c]Stepwatch[TM] Orthocare Innnovations, 840 Research Parkway, Suite 200, Oklahoma City, OK 73104
[d]SPSS Inc, Chicago, IL

### Physical Activity Patterns

Stepwatch recordings were available for a median of 5 days (range: 3 to 18 days), a sufficient duration for cross-sectional descriptions of physical activity patterns.[24, 25] The COPD sample engaged in the lowest amount of ambulatory physical activity compared to the two cardiac samples-total daily steps were 5319 vs. 7464 vs. 9570, p<.001 (Table II). The total daily step count for subjects with cardiac dysrhythmias was comparable to that of healthy adults.[26, 27] The COPD subjects also spent the lowest percentage of time being active but this was only significantly different from subjects with cardiac dysrhythmias (32% vs. 38%, p<.05). The two cardiac samples spent a similar percentage of time in medium intensity walking activity (25% and 27%) and were both significantly higher than the COPD sample (22%). Subjects with COPD spent most of their active time in low intensity activity (76%) in contrast to subjects with cardiac dysrhythmias who spent 66% of their time in low intensity activity. Peak performance was significantly different across groups with the cardiac dysrhythmias sample having the highest step rate. MaxSteps30 which captures the highest step rate in 30 minutes and is a proxy for walking intensity during a typical recommended bout of endurance exercise showed that subjects with COPD performed only 51% of their walking capacity (peak performance) compared to 61–66% in the cardiac samples.

### Bivariate Correlations

In the COPD sample, six minute walk distance had moderate to high correlations (r=.44 to .65, p<.01) with all seven physical activity dimensions, the strongest correlations being with total steps and peak performance (Table III & Figure IA). Airway obstruction (FEV1% predicted) had small to moderate correlations with all (r=.30 to −.45, p<.01) but one dimension of physical activity, percent time active. Self-reported physical functioning was correlated only with peak performance (r=.27, p<.05). Age, BMI and mental health functioning were not significantly correlated with any of the physical activity dimensions whereas higher chronic disease burden was associated with less time spent in high intensity walking activity (r=−.26, p<.05).

Maximal oxygen consumption had only small to moderate correlations with five of the seven physical activity dimensions (r=.22 to .40, p<.05) in the combined cardiac sample (Table IV); the strongest correlations were with total steps and peak performance (Figure IB). In contrast, correlations between distance covered on a six minute walk test with five physical activity dimensions were higher (r=.48 to .61, p<.01) albeit in a smaller sample of only patients with heart failure. Higher comorbidity was associated with less physical activity (r=−0.27 to −0.44, p<.01) but ejection fraction was only correlated with time spent in high intensity walking activity (r=.19) and peak performance (r=.26). Self-reported physical functioning had small to moderate correlations with six of the seven physical activity dimensions (r=.22 to .37, p<.05). Age, FEV1% predicted, BMI and mental health functioning were not significantly correlated with any of the physical activity dimensions with the exception of percent time active and BMI.

## DISCUSSION

The primary finding from this study which used a highly accurate ankle mounted accelerometer showed that all dimensions of ambulatory physical activity discriminated between subjects with COPD, heart failure, and cardiac dysrhythmias. Specifically, subjects with COPD engaged in the lowest volume of ambulatory physical activity followed by subjects with heart failure, and cardiac dysrhythmias. To the best of our knowledge, we are not aware of any other published reports that have compared physical activity patterns across three cardiopulmonary conditions. In both subjects with COPD and cardiac

impairment, all seven physical activity dimensions had the highest correlations with distance covered on a six minute walk test; smaller, less consistent associations were found between physical activity and self-reported physical functioning and airway obstruction in the COPD sample and self-reported functioning, ejection fraction, and maximum oxygen consumption in patients with cardiac impairment. In addition, age, body mass index and mental health functioning were not related to any of the physical activity dimensions for all subjects. These collective findings suggest that physical activity as measured by an accelerometer provides unique, important information about real-world behavior in patients with COPD, heart failure, and cardiac dysrhythmias not already captured with existing instruments.

Tudor-Locke et al.[28] established pedometer-determined physical activity cut points for healthy adults as: <2500 steps/day (basal physical activity), 2500 to <5000 steps/day (limited physical activity), 5000-<7500 (low activity), 7500 to <10,000 (somewhat active), 10,000 to <12,500 (active), and >12,500 (highly active). Recently, a review of 28 studies that included older adults aged 50–94 showed mean pedometer-determined physical activity ranged from 2,015 steps/day to 8,938 steps/day.[29] Based on these classifications, our COPD sample is considered to be in the low activity category but well within the range of expected step counts for older adults. Earlier studies of patients with COPD that used different activity devices showed similar total step counts and distribution of activity intensity as our study.[13, 25, 30–32]

Since this is the first study to report physical activity patterns in patients with cardiac dysrhythmias, we did not have any benchmark to compare our findings. We were surprised to find the relatively high total step count in subjects with cardiac dysrhythmias. Tudor-Locke et al.'s classification would place them in the "somewhat active" to "active" category[28] and having the highest step count in comparison to ten other chronic conditions.[33] Their younger age, limited physical impairment and few comorbid conditions partly explain their ability to engage in a higher volume of physical activity, i.e., more steps, active time, and time spent in high and moderate intensity walking activity. The total step count for subjects with heart failure is similar to one other published study that had a higher percentage of women in the sample compared to our study.[12]

It is interesting to note that MaxSteps30 which is a proxy for continuous ambulatory exercise intensity over a 30 minute interval was as low as 51% (COPD sample) to 67% (cardiac dysrhythmias sample) of the peak performance step rate. These data suggest that patients with cardiopulmonary illnesses likely engage in only low to moderate intensity walking exercises when they are unsupervised. Two recent studies of patients with COPD that measured either total energy expenditure using an arm-mounted device or oxygen uptake during five self-paced activities of daily living using a portable metabolic cart found that patients use a high proportion of their peak aerobic capacity (55% to 85% of $O_2$ peak) to perform daily activities.[34, 35]. If indeed patients with COPD are already exerting themselves at close to peak capacity with routine domestic ADLs, it is only understandable that they may not have sufficient reserve and/or desire to perform their independent walking exercises at a higher intensity. Further research is needed to understand this relationship between metabolic load experienced during domestic ADLs and exercise intensity.

Although the highest correlations between the seven physical activity dimensions were with distance walked on a six minute walk test, these correlations were not as high as a previous study of COPD patients which used an older model accelerometer that measured activity in vector magnitude units (r=.74).[36] The finding of only small correlations between VO2max with five of the seven activity dimensions in this study is in contrast to findings by Jehn et al.[12, 37] where a different activity monitor and cycle ergometer protocol were used. The correlation between total time walked and VO2max was 0.72 in that study. Differences in

the magnitude of associations between various measures of laboratory exercise performance and physical activity across studies could also partly be due to the stability of the estimates and degree of variability in the correlates. Nevertheless, the consistent small to moderate correlations between the seven physical activity dimensions with self-reported physical functioning and disease severity across the three samples suggest that the measurement of actual physical activity behavior provides additional valuable information on functional impairments associated with cardiopulmonary illnesses and may also contribute to better prediction of survival in these clinical populations.[5]

### Study Limitations

There are several limitations to this descriptive study. A limitation of the Stepwatch, similar to most other activity monitors on the market, includes the inability to measure activities of the upper extremity and other activities such as bicycling. While lower limb activity cannot be substituted for estimates of total energy expenditure, it is clearly a major determinant of energy expenditure ($r=0.92$) and in most circumstances, is an acceptable surrogate[13]. Because the combined data set emanated from three clinical intervention studies that had specific inclusion and exclusion criteria, the findings may not be generalizable to the broader population of patients with cardiopulmonary illnesses who are more severely affected by their condition and were unable to participate in the clinical trials or were insufficiently active to benefit from an exercise intervention. The COPD and heart failure samples were comprised mostly of men thus the findings may not extend to women; in addition, the heart failure sample was relatively small Seasonal variations may affect physical activity patterns.[38] Baseline measurements across the three RCTS were performed throughout the year though this may not fully account for the variability in the activity patterns.

## CONCLUSIONS

Findings from this study provide a useful benchmark of physical activity patterns in individuals with cardiopulmonary illness for comparison with future studies. All seven dimensions of ambulatory physical activity discriminated between subjects with COPD, heart failure, and cardiac dysrhythmias. Depending on the research or clinical goal, use of one dimension such as total steps may be sufficient. Although physical activity had high correlations with performance on a six minute walk test relative to other variables, accelerometry-based physical activity monitoring provides unique, important information about real-world behavior in patients with cardiopulmonary not already captured with existing measures.

## Acknowledgments

## ABRREVIATIONS

| | |
|---|---|
| **COPD** | Chronic obstructive pulmonary disease |
| **FEV1** | Forced expiratory volume in 1 second |

| FVC | Forced vital capacity |
|---|---|
| **EF** | Ejection fraction |
| **ICD** | Implantable cardioverter defibrillator |
| **ATS** | American Thoracic Society |
| **6MWT** | Six minute walk test |
| **SAM** | Stepwatch activity monitor |
| **HRQL** | Health related quality of life |
| **VO2 max** | Maximal oxygen consumption |

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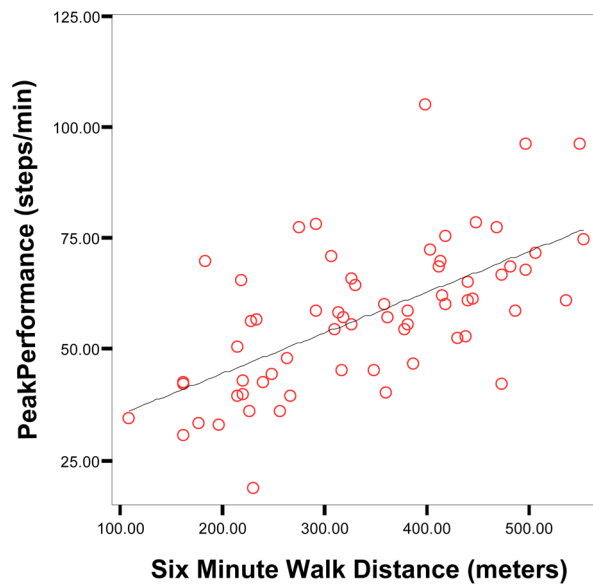
Linear Regression



Linear Regression
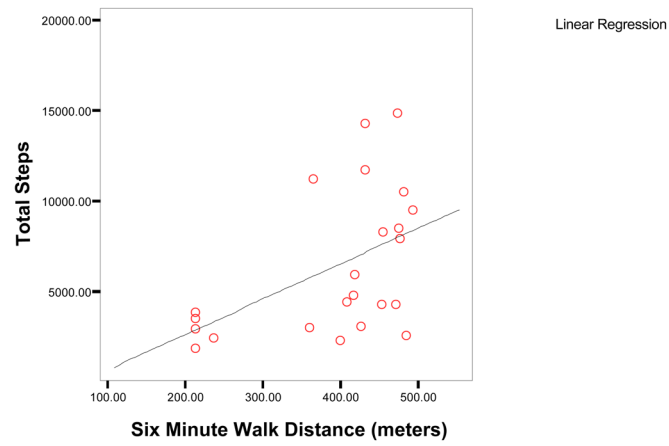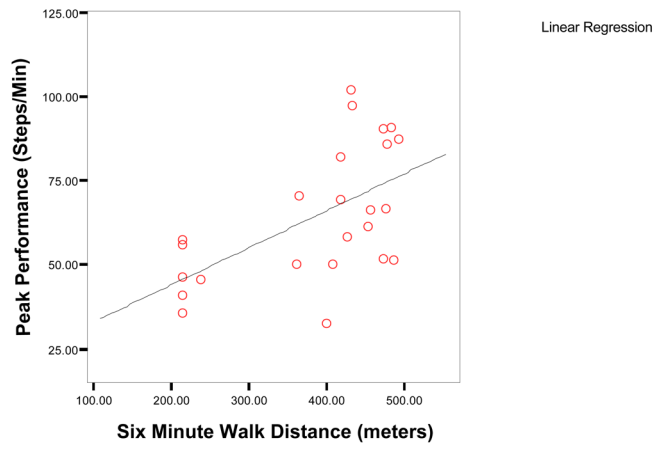
**Figure I.**
Figure IA. Scatterplots of Six Minute Walk Distance, Total Steps, and Peak Performance in Subjects with COPD (n=63)
Figure IB. Scatterplots of Six Minute Walk Distance, Total Steps, and Peak Performance in Subjects with Heart Failure (n=24)

**Figure II.**
Scatterplots of VO2Max, Total Steps, and Peak Performance in Subjects with Heart Failure and Cardiac Dysrhythmias (n=96)

**Table I**

Subject Characteristics

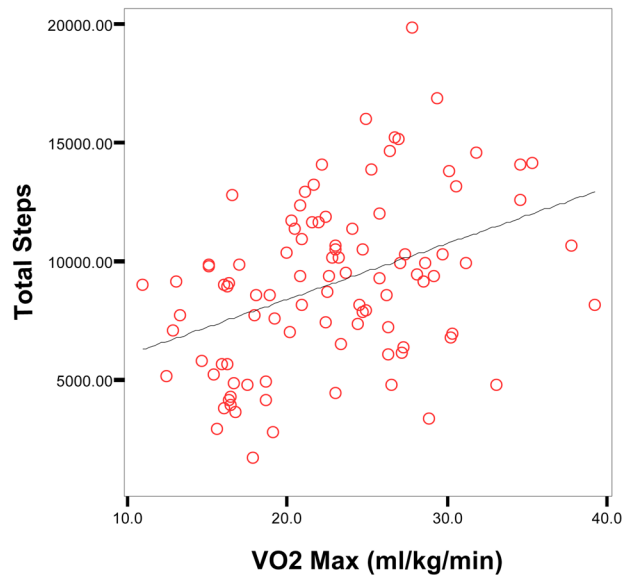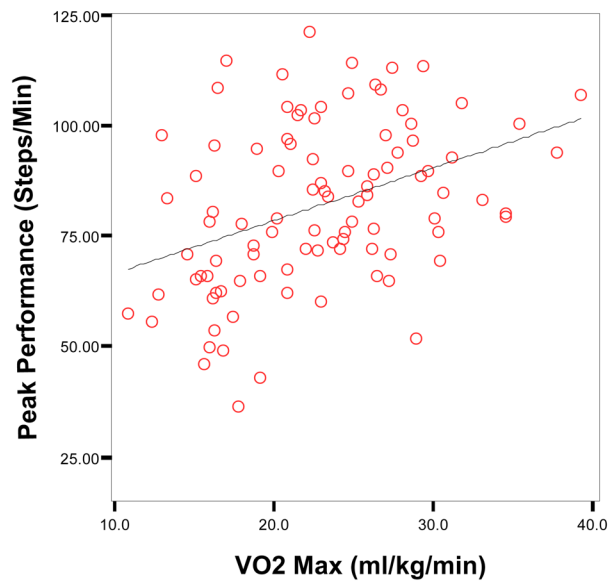| | COPD n = 63 | | Heart Failure n = 60 | | Cardiac Dysrhythmias n = 60 | | Total n = 183 | | ANOVA* p |
|---|---|---|---|---|---|---|---|---|---|
| Age | 67.0. | (9.3) | 60.5 | (10.8) | 55.4 | (11.6) | 61.1 | (11.6) | $<.001$ [†,‡,§] |
| Gender (Male) | 58 | (91%) | 57 | (95%) | 44 | (72%) | 159 | (86%) | $<.001$[‡,§] |
| Ethnicity (Caucasian) | 53 | (83%) | 48 | (80%) | 58 | (95%) | 159 | (86%) | .04[†,‡,§] |
| Education (At least some college) | 31 | (48%) | 41 | (73%) | 44 | (72%) | 119 | (64%) | .006[†,‡] |
| Body Mass Index (BMI) | 29.7 | (7.0) | 30.5 | (7.0) | 29.0 | (6.0) | 29.7 | (6.7) | .46 |
| Charlson Comorbidity Index | 1.6 | (1.2) | 2.3 | (1.3) | 1.0 | (0.9) | 1.6 | (1.2) | $<.001$[†,‡,§] |
| Ejection Fraction | 55% | (8) [n=25] | 27% | (7) | 49% | (11) | 41% | (15) | $<.001$[†,§] |
| Spirometry | | | | | | | | | |
| FEV1 % Predicted | 36 | (15) | 72 | (20) | 85 | (15) | 64 | (27) | $<.001$[†,‡,§] |
| FVC % Predicted | 57 | (16) | 73 | (17) | 85 | (14) | 72 | (20) | $<.001$[†,‡,§] |
| FEV1/FVC | 0.46 | (0.16) | 0.73 | (0.11) | 0.73 | (0.08) | 0.64 | (0.17) | $<.001$[†,‡] |
| Health Related Quality of Life (HRQL) | | | | | | | | | |
| SF-36 Physical Component Score | 30.7 | (7.7) | 42.7 | (11.8) | 51.2 | (9.0) | 41.4 | (12.8) | $<.001$[†,‡,§] |
| SF-36 Mental Component Score | 45.3 | (13.0) | 43.4 | (8.6) | 40.7 | (6.3) | 43.1 | (9.9) | .035 |
| Exercise Performance | | | | | | | | | |
| Six Minute Walk (meters) | 340.2 | (113.1) | 385.2 | (104.4) [n=24] | --- | --- | 353.6 | (112) | .094 |
| VO2 Max (mL/min/kg) | --- | --- | 20.3 | (5.3) [n=36] | 24.4 | (6.1) | 22.8 | (6.1) | .001 |

Values shown are mean(sd) or count(%)

Abbreviations: EF: Ejection Fraction; FEV1 = Forced Expiratory Volume in 1 second; FVC = Forced V Capacity; VO2Max: Maximum oxygen consumption

*
Overall group comparison; Pairwise comparisons with Bonferroni corrections: p<.05,

†
COPD vs. Heart Failure,

‡
COPD vs. Cardiac Dysrhythmias, and

§
Heart Failure vs. Cardiac Dysrhythmias

**Table II**

Ambulatory Physical Activity Across Cardiopulmonary Diseases

| | COPD | | Heart Failure | | Cardiac Dysrhythmias | | Total | | F Statistic | ANOVA * |
|---|---|---|---|---|---|---|---|---|---|---|
| | n = 63 | | n = 60 | | n = 60 | | n = 183 | | | p |
| Total Steps | 5319 | (2712) | 7464 | (3724) | 9570 | (3622) | 7416 | (3783) | 24.4 | <.001 †, ‡, § |
| % Time Active | 32 | (14) | 35 | (12) | 38 | (11) | 35 | (13) | 4.1 | .015 ‡ |
| % Time High Intensity (> 80steps/min) | 2 | (2) | 5 | (5) | 7 | (5) | 4 | (5) | 19.4 | <.001 †, ‡, § |
| % Time Med Intensity (31–80 steps/min) | 22 | (8) | 25 | (8) | 27 | (6) | 25 | (8) | 9.5 | <.001 †, ‡ |
| % Time Low Intensity( 30 steps/min) | 76 | (9) | 70 | (10) | 66 | (8) | 71 | (10) | 22.4 | <.001 †, ‡, § |
| Peak Performance (steps/min) | 57 | (16) | 71 | (20) | 85 | (18) | 71 | (21) | 38.4 | <.001 †, ‡, § |
| Max Steps 30 (steps/min) | 28 | (12) | 43 | (23) | 57 | (24) | 43 | (23) | 26.9 | <.001 †, ‡, § |

Values shown are mean(sd)

*
Overall group comparison; Pairwise comparisons with Bonferroni corrections: p<.05,

†
COPD vs. Heart Failure,

‡
COPD vs. Cardiac Dysrhythmias, and

§
Heart Failure vs. Cardiac Dysrhythmias

**Table III**

Correlations Between Physical Activity Dimensions with Demographics, Health Status, and Exercise Performance in Patients with COPD (n=63)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Total Steps | 1.00 | | | | | | | | | | | | | |
| 2. % Time Active | .85¶ | 1.00 | | | | | | | | | | | | |
| 3. % Time High Intensity | .53¶ | .25// | 1.00 | | | | | | | | | | | |
| 4. % Time Medium Intensity | .63¶ | .32// | .30// | 1.00 | | | | | | | | | | |
| 5. % Time Low Intensity | −.68¶ | −.33‡ | −.63‡ | −.98‡ | 1.00 | | | | | | | | | |
| 6. Peak Performance | .87¶ | .62¶ | .80¶ | .70¶ | −.80¶ | 1.00 | | | | | | | | |
| 7. Max Steps 30 | .79¶ | .60¶ | .75¶ | .54¶ | −.65¶ | .90¶ | 1.00 | | | | | | | |
| 8. 6MW Distance | .64¶ | .51¶ | .47¶ | .53¶ | −.57¶ | .65¶ | .44¶ | 1.00 | | | | | | |
| 9. Age | −.22 | −.19 | −.09 | −.11 | .12 | −.13 | −.07 | −.22 | 1.00 | | | | | |
| 10. BMI | .02 | −.08 | .09 | .22 | −.21 | .08 | .13 | −.21 | −.09 | 1.00 | | | | |
| 11. FEV1%Pred | .30// | .15 | .44¶ | .40¶ | −.45¶ | .43¶ | .39¶ | .17 | .10 | .41¶ | 1.00 | | | |
| 12. Co-Morbidity | −.17 | −.09 | −.26| | −.15 | .19 | −.17 | −.12 | −.22 | .23 | .23 | −.10 | 1.00 | | |
| 13. SF-36 PCS | .18 | .15 | .28 | .18 | −.22 | .27// | .22 | .41¶ | .03 | −.06 | .01 | .04 | 1.00 | |
| 14. SF-36 MCS | −.06 | −.15 | .19 | −.06 | .00 | .04 | .07 | −.02 | .22 | −.01 | .06 | .09 | .17 | 1.00 |

// p< 0.05,

¶ p<0.01

**Table IV**

Correlations Between Physical Activity Dimensions with Demographics, Health Status, and Exercise Performance in Patients with Heart Failure and Cardiac Dysrhythmias (n=96)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Total Steps | 1.00 | | | | | | | | | | | | | | | |
| 2. % Time Active | .78¶ | 1.00 | | | | | | | | | | | | | | |
| 3. % Time High Intensity | .45¶ | .01 | 1.00 | | | | | | | | | | | | | |
| 4. % Time Medium Intensity | .50¶ | .35¶ | −.03 | 1.00 | | | | | | | | | | | | |
| 5. % Time Low Intensity | −.68¶ | −.27¶ | −.64¶ | −.75¶ | 1.00 | | | | | | | | | | | |
| 6. Peak Performance | .74¶ | .39¶ | .82¶ | .22// | −.71¶ | 1.00 | | | | | | | | | | |
| 7. Max Steps 30 | .69¶ | .33¶ | .83¶ | .15 | −.66¶ | .91¶ | 1.00 | | | | | | | | | |
| 8. VO2 Max | .40¶ | .34¶ | .22// | .06 | −.19 | .39¶ | .31¶ | 1.00 | | | | | | | | |
| 9. 6MWD (n=24) | .52¶ | .59¶ | .48// | .25 | −.38 | .58¶ | .61¶ | -- | 1.00 | | | | | | | |
| 10. Age | −.09 | −.14 | .03 | −.02 | .00 | −.08 | .05 | −.41¶ | −.26 | 1.00 | | | | | | |
| 11. BMI | −.18 | −.25// | −.07 | .02 | .03 | −.19 | −.16 | −.45¶ | −.06 | .15 | 1.00 | | | | | |
| 12. FEV1%Pred | .19 | .17 | .03 | .15 | −.13 | .13 | .10 | .34¶ | .41 | .03 | −.09 | 1.00 | | | | |
| 13. EF | .12 | .01 | .19// | −.01 | −.12 | .26¶ | .16 | .33¶ | .10 | −.16 | −.07 | .22// | 1.00 | | | |
| 14. Comorbidity | −.35¶ | −.29¶ | −.27¶ | −.14 | .29¶ | −.44¶ | −.36¶ | −.51¶ | −.36 | .30¶ | .24// | −.12 | −.42¶ | 1.00 | | |
| 15. SF-36 PCS | .35¶ | .21 | .23// | .22// | −.32¶ | .37¶ | .27¶ | .29¶ | .39 | −.02 | .06 | .14 | .11 | −.18 | 1.00 | |
| 16. SF-36 MCS | .03 | .07 | −.01 | .00 | .01 | −.02 | −.05 | −.01 | .15 | .16 | .08 | .12 | −.15 | .19 | .19 | 1.00 |

//
p< 0.05.

¶
p< 0.01